Matsumura's Collection of Froghoppers and Sharpshooters (Hemiptera: Cicadomorpha) of Taiwan in the Hokkaido University Insect Collection

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ABSTRACT

The Laboratory of Systematic Entomology, Faculty of Agriculture, Hokkaido University, Sapporo, Japan (SEHU), former Entomological Institute of Sapporo Agricultural College, was founded by Professor Shonen Matsumura. SEHU has preserved the insect specimens named by Professor Matsumura for a long time that includes insect specimens collected from Taiwan. Some of them are xylem-feeders, such as froghoppers and sharpshooters which can transmit xylem-limited bacteria (XLB). This article provides the checklist of Taiwan froghoppers and sharpshooters named by Professor Matsumura preserved in SEHU. The checklist contains 44 froghopper species and 4 sharpshooter species. This checklist could be a reference for studying the taxonomy of xylem-feeders in Taiwan.

Keywords: Taiwan, froghopper, sharpshooter, Hokkaido University, Shonen Matsumura

INTRODUCTION

Xylem feeders belonging to Hemiptera are capable to transmit xylem-limited bacteria (XLB). Therefore, these xylem feeders were considered as potential vectors of XLB [(34)]. Some of the xylem feeders confirmed as vectors of XLB belong to Cercopoidea (commonly known as froghoppers or spittlebugs) and Cicadellinae

(commonly known as sharpshooters) [1, 3, 9, 33, 34, 35, 38].

The known species of xylem-limited bacteria in Asia are *Ralstonia syzygii* and *Xylella fastidiosa* [2, 7, 15, 45]. The vector of transmitting *Ralstonia syzygii* is *Hindola striata* (Machaerotidae of Cercopoidea). In order to identify the vectors that transmit Pierce's disease of grapevines occurred in Taiwan, the survey of xylem feeders which harvest *Xylella fastidiosa* was performed. The results showed that the DNA fragments of *X. fastidiosa* could be detected in three cicadelline species (*e.g. Kolla paulula* (Walker, 1858), *Bothrogonia ferruginea* (Fabricius, 1787), and *Anatkina horishana* (Matsunura, 1912)), and one aphrophorid species (*Poophilus costalis* (Walker, 1851)). Therefore, these four insects were considered as candidate vectors (Su *et al*., 2011; Su *et al*., 2013). Among them, *Kolla paulula* and *Bothrogonia ferruginea* were confirmed as insect vectors through Koch's postulates (Su and Shih, unpublished data).

There were 100 cercopoid species and 18 cicadelline species recorded in Taiwan [21, 30, 36, 37, 39, 40, 41, 43, 47, 48]. Among them, 48 species (40.7% of known species), including 44 froghoppers and 4 sharshooters, were named by a Japanese insect taxonomists, Professor Shonen Matsumura (1872-1960) (Fig. 1). Professor Matsumura was the father of Japan entomology. He was born in Akashi, Hyogo Prefecture, Japan. Professor Matsumura published 240 reports and 35 books between 1895 and 1945 (Liang and Suwa, 1998). Insect specimens Professor Matsumura worked on were mainly from East Asia, such as Japan, Korea, China, Taiwan, and Sakhalin (Sakhalin) [13, 17]. Most of the specimens are still stored at the laboratory of Systematic Entomology, Faculty of Agriculture, Hokkaido University, Sapporo, Japan (SEHU) [13].

Professor Matsumura described the froghopper and leafhopper species of East Asia based on body color and external morphology (e.g. the structures and sharps of antennal ledge, tylus, frons, and clypeus). However, the difference of male genital structures was not included. Therefore, examinations of the type specimens are crucial in proper identification of these species. Based on the subsequent examinations of the type specimens, some of the diagnostic features used by Matsumura have been identified as the differences between individuals or genders. Therefore, lots of species he described were now treated as synonyms [10, 11, 12, 14, 16, 31].

So far, four species were identified as PD candidate insect vectors, which are only 3.4% of the total froghoppers and leafhoppers known in Taiwan. Therefore, it is still possible to find other candidate insect vectors in the future. The correct information of classification and identification of froghoppers and leafhoppers are

required for further studies on ecology and prevention of these candidate insect vectors. For this purpose, this article provides a checklist of Cercopoidea and Cicadellinae of Taiwan from the Matsumura's collection at SEHU.

Fig. 1. Professor Shonen Matsumura.

A checklist and remarks of Taiwan froghoppers and sharpshooters named by Shonen Matsumura

Type specimens of Cercopoidea [13] and Cicadellinae of Taiwan described by Professor Matsumura were preserved at SEHU. The type localities of froghoppers and sharpshooters in the checklist refer to Matsumura's original descriptions [18, 19, 20, 21, 22, 23, 24, 25, 26]. The synonymies follow Metcalf [27, 28, 29, 30] and Shih and Yang [39, 40].

Family Aphrophoridae

1. *Aphrophora arisana* Matsumura, 1940

Distribution: Taiwan.

2. *Aphrophora habonis* (Matsumura, 1940)

Distribution: Taiwan.

3. *Aphrophora horishana* Matsumura, 1940

Distribution: Taiwan.

4. *Aphrophora kikuchii* (Matsumura, 1940)

Distribution: China, Taiwan.

5. *Aphrophora maritima* Matsumura, 1903 New Record

Distribution: China, Japan, Korean Peninsula, Taiwan (Matsu Is.)

Specimens examined: CHINA: 1♂, Fujian, Chongan, 580-650 m, 21. V. 1960, C. L. Ma; 1♀, Fujian, Chongan, 580-650 m, 19. VI. 1960, Y. R. Zhang; TAIWAN**:** 1♀, Machu, Hsijiu Island, Tienau, 14. V. 2002, J. A. Pan; 1♂, Machu, Dungyin Island, Chungliu, 4. VI. 2002, H. T. Shih; 2♂, 1♀, Machu, Hsijiu Island, Tienau, 3. IX. 2002, W. H. Chen & T. Y. Chang.

Remarks: In 2002, HTS found that nymphs of this species feed on the stems or roots of *Angelica* sp. (Umbelliferae) at Hsijiu Island, Machu, Fujian.

6. *Aphrophora mushana* (Matsumura, 1940)

Distribution: Taiwan.

7. *Aphrophora nagasawae* Matsumura, 1907

Distribution: Taiwan.

8. *Aphrophora nomurella* (Matsumura, 1942a)

Distribution: Taiwan.

9. *Aphrophora arisanella* (Matsumura, 1940)

Distribution: Taiwan.

10. *Aphrophora tsuruana* Matsumura, 1907

Distribution: China; Taiwan.

11. *Jembrophora sawadai* Matsumura, 1942a

Distribution: Taiwan.

12. *Jembra inouyei* (Matsumura, 1942a)

Distribution: Taiwan.

13. *Jembrana centralis* Matsumura, 1940

Distribution: Taiwan.

14. *Jembrana daitoensis* Matsumura, 1940

Distribution: Taiwan.

15. *Jembrana kankonis* Matsumura, 1942a

Distribution: Taiwan.

16. *Jembrana kanoniella* Matsumura, 1940

Distribution: Taiwan.

17. *Nokophora nokoensis* Matsumura, 1940

Distribution: Taiwan.

18. *Ariptyelus arisanus* (Matsumura, 1942b)

Distribution: Taiwan.

19. *Ariptyelus auropilosus* (Matsumura, 1907)

Distribution: Taiwan.

20. *Peuceptyelus excavatus* (Matsumura, 1940)

Distribution: Taiwan.

21. *Peuceptyelus kanmonis* (Matsumura, 1940)

Distribution: Taiwan.

22. *Peuceptyelus nigriceps* (Matsumura, 1940)

Distribution: Taiwan.

23. *Peuceptyelus nitobei* (Matsumura, 1940)

Distribution: Taiwan.

24. *Peuceptyelus rokurinzana* (Matsumura, 1940)

Distribution: Taiwan.

25. *Peuceptyelus takaosanus* Matsumura, 1934

Distribution: Taiwan.

26. *Nagaclovia formosana* Matsumura, 1940

Distribution: China, Taiwan, Japan (Okinawa).

27. *Lepyronia okadae* (Matsumura, 1903)

Distribution: China, Japan, Korean Peninsula, Taiwan.

28. *Philaenus arisanus* Matsumura, 1940

Distribution: Taiwan.

29. *Philaenus mushanus* Matsumura, 1940

Distribution: Taiwan.

30. *Philaenus nigripectus* (Matsumura, 1903)

Distribution: Taiwan.

31. *Mesoptyelus arisanus* Matsumura, 1940

Distribution: China, Taiwan.

32. *Mesoptyelus karenkonis* Matsumura, 1940

Distribution: Taiwan.

33. *Ptyelus tamahonis* Matsumura, 1940

Distribution: Taiwan.

34. *Philagra kanoi* Matsumura, 1940

Distribution: Taiwan.

35. *Philagra kuskusuana* Matsumura, 1942b

Distribution: Taiwan.

36. *Kotophora botelensis* (Matsumura, 1938)

Distribution: Taiwan.

Family Cercopidae

37. *Tadascarta rubripennis* Matsumura, 1940

Distribution: Taiwan.

38. *Eoscarta zonalis* (Matsumura, 1907)

Distribution: Taiwan, Japan, China.

39. *Baibarana uchidai* Matsumura, 1940

Distribution: Taiwan.

40. *Kuscarta koshunella* Matsumura, 1940

Distribution: Taiwan.

41. *Kanozata arisana* Matsumura, 1940

Distribution: Taiwan.

42. *Cosmoscarta uchidae* Matsumura 1906

Distribution: Daito Island, Ryukyu Islands, Taiwan.

43. *Kanoscarta kanoniella* Matsumura, 1940

Distribution: Taiwan.

44. *Eoscarta bimaculata* (Matsumura, 1907)

Distribution: China, Japan, Taiwan.

Family Cicadellidae

Subfamily Cicadellinae

45. *Anatkina hopponis* (Matsumura, 1912)

Tettigonia hopponis Matsumura, 1912, Annot. Zool. Jap. 8: 37-38.

Anatkina hopponis (Matsumura) [transferred by Young 1986: 46].

Distribution: Taiwan.

46. *Anatkina horishana* (Matsunura, 1912)

Tettigoniella horishana Matsumura 1912: 36-37.

Anatkina horishana (Matsumura) [transferred by Young 1986: 46].

Distribution: Taiwan.

47. *Atkinsoniella rinkihonis* (Matsumura, 1912)

Tettigoniella rinkihonis Matsumura 1912: 36.

Atkinsoniella rinkihonis Young 1986: 97. [transferred by Young 1986: 46].

Distribution: Taiwan.

48. *Bothrogonia formosana* (Matsumura, 1912)

Tettigonia formosana Matsumura 1912: 34.

Remarks: Ishihara [8] concluded that *B. formosana* (Mats.) should be identified as *B. ferruginea*.

Future Prospects

In addition to Prof. Matsumura, the other key scholar of froghoppers of Taiwan was Masayo Kato. However, the depository of Masayo Kato's collection is still unknown. Furthermore, neither Matsumura nor Kato has studied the male genital structures of froghoppers and leafhoppers, and many species were described based on the superficial differences, or sometimes difference in coloration, only. Numerous studies on color polymorphism of *Philaenus* (Cercopoidea) have been performed [4, 32, 46, 49, 50, 51]. Through these studies, it has been confirmed that intraspecific color polymorphism exists in some species of Cercopoidea. For example, chromosomal alleles, eographic and climatic factors were suspected to influence intraspecific color polymorphism of *P. spumarius* (L.) [5, 6]. Therefore, inspection of Mstsumura's collection stored at SEHU is especially crucial in solving some taxonomic problems regarding the Taiwanese species possibly described on the bases of intraspecific color polymorphism. These will greatly contribute for establishing the base for classification of potential insect vectors that transmit xylem-limited bacteria in Taiwan.

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